THE BIOPERSITENCE AND BIOACCUMULATON OF AMPHIBOLE ASBESTOS AND VITREOUS FIBRES.

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Interest in the ability of toxic materials to persist in the body is widespread with a group of persistent bioaccumulative toxic (PBT) materials receiving special attention. This group includes amphibole asbestos, which can accumulate in the lung to a greater level than other fibres and persists longer after exposure ceases. This has been known since Wagner[1] demonstrated that crocidolite followed this pattern and further evidence is provided by the fact that amphiboles are the most common fibre type in the lungs of persons exposed to mixtures containing predominantly chrysotile.

The use of biopersistence as a regulatory tool in the European Union classification of man-made vitreous fibres[2] is an outgrowth of research into this phenomenon carried our over the last ten years. Biopersistence is clearly related to chemical composition but the preferential phagocytosis of short fibres exposes long and short fibres to different environments. Hence they may dissolve through different mechanisms. There is strong evidence that fibres greater than 20 µm long are most responsible for pathogenesis and this provides part of the justification for the concentration on long fibres in the EU classification. However shorter fibres must have some pathogenic activity and therefore it is difficult to justify using any one measure to summarise fibre clearance. However we suggest that long fibre clearance is a consistent, relevant and reproducible measure related to risk.

For relatively insoluble fibres such as e-glass and amphibole asbestos the clearance of long and short fibres was similar but for more soluble fibres, such as most man made silicate wools, long fibres cleared preferentially. The different roles of solubility and cell-mediated clearance could be distinguished by differences in the accumulation and persistence of amphibole asbestos, glass fibres, and glass particles. The clearance of glass fibres continued even under conditions where macrophage mediated clearance has collapsed due to pulmonary overload.

Short fibre clearance is largely unaffected by particle properties, these fibres are phagocytosed by macrophages and, whether soluble in that compartment or not, they are cleared from the lung unless prevented by very high lung burdens unlikely to occur in man. The pool of short fibres is also influenced by the corrosion, and transverse breakage of long fibres. Therefore being the result of several processes, the clearance of short fibres is complex and, perhaps, less directly related to the conditions after human exposure. This does not rule out, however, the possibility that some short fibres, even if soluble under extracellular conditions, will be toxic to macrophages and accumulate to dangerous concentrations especially as their number may be enhanced by fragments of longer fibres. Despite the possible contributions of short fibres to pathogenicity, overall the clearance of long fibres is a biologically relevant measure directly related to the fibre's material properties and predictive of biological effect.

These considerations have identified considerable gaps in our knowledge on the biopersistence, bioaccumulation and toxic properties of chrysotile asbestos.

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[1] Quoted in IARC Monograph Volume 14 – Asbestos WHO International Agency for Research on Cancer Lyon 1977

[2] EU directive 97/69/EC 1997